

Synthesis

Overview

Once the module analysts have worked through the methods addressing the critical questions, they will reach a point where they cannot go much further in developing a more comprehensive picture of the watershed and linkages between sources, channels and public resources without interaction with other team members. This begins the second major stage of resource assessment where the team works together to complete the watershed interpretation. Like the inventory stage where modules are completed, synthesis is a stepped and iterative process that may require inter-module and full group meetings, and could include additional data gathering if the team finds it necessary to test hypotheses. The primary qualities that distinguish the synthesis stage of resource assessment is the inter-disciplinary nature of the dialogue and the focus of the group at the watershed scale.

The purpose of synthesis is to bring together the information gathered in the inventory stage (resource assessment modules) to link resource effects to existing or potential hazards and to consider the existing and potential cumulative effects of forest practices. To determine whether the contributing activities in the sensitive area will cause significant changes in the stream, a watershed assessment team must work both ends of an input pathway (Figure 4), defining the likelihood of a change in an input and the effect on a resource if a change occurs. This development of watershed-scale linkages and hypotheses is currently performed qualitatively by the interdisciplinary resource assessment team. It is the hope that future versions of this manual will be able to include more quantitative methods for establishing linkages and testing hypotheses. Level 2 teams are encouraged to attempt more quantitative assessments but must provide rationale and justification.

As with the resource assessment modules, the team is guided by a series of critical questions as they attempt to synthesize the results of the individual module assessments into a comprehensive watershed story:

- What and where are the potential impacts altering the input variables?
- Are the inputs delivered to the response segments of concern and if so in what quantity?
- What is the channel sensitivity to the inputs?

- What is the habitat or public resource vulnerability to the inputs?

The team answers the questions with empirical evidence developed primarily in the inventory modules. The evidence will include:

- Presence of activities are altering (or may alter) inputs related to the process under consideration (e.g., logging road failures generating coarse materials).
- Input reaching the stream system (or is likely to).
- Routing through the stream system to locations of vulnerable resources.
- Public resources sensitive to the input are present in the reach under consideration (e.g., rearing habitat is sensitive to inputs of coarse sediment).
- Resource conditions in a stream segment that can be adversely affected or the current rate of inputs is such that an already affected/degraded condition will not improve (the coarse material that is generated is likely to accumulate in pools with expected reduction in pool volume).

The team focuses on representative indicator areas selected as likely locations of resource effects. The initial delineation of areas is provided by the Fish and Channel teams. Watershed processes and resource conditions are linked along common themes of the effects on or responses to the five input variables (i.e., coarse and fine sediment, wood, water, and heat energy).

Confirmation procedures establish what is required in terms of evidence and indicators; these are used to establish cause and effect with reasonable confidence. The team uses an iterative approach of hypothesis development and testing based on the strength of the supporting evidence; alternative hypotheses are developed if the signals of cause and effect are present but weak. The team may decide to generate more information to resolve uncertainties.

A confirmed hypothesis results in the identification of a sensitive area. The problem statement is referred to as a situation sentence which has supporting evidence; the “sentence” is a statement or paragraph that summarizes key processes and relationships. This is captured in a causal mechanism report that describes location, impact mechanisms, linkage to vulnerable resources and the rule call. The rule matrix is performed to determine the Rule Call, which sets the standard of performance in preventing changes in watershed processes for the prescriptions to be developed for the sensitive area. The sensitive areas are the mapped units resulting from the Mass Wasting, Surface Erosion, Hydrology and Riparian Function Modules. The units are termed “sensitive areas” once an effect on public resources is estab-

lished. The causal mechanism report is given to the field managers team to develop appropriate prescriptions.

A problem statement for each resource sensitivity includes identification of active processes (e.g., surface erosion), contributing management activities, channel effects, and effects on a resource characteristic (e.g., loss of spawning habitat). Synthesis also produces the ratings of resource vulnerability, resource condition, and delivered hazard required under the cumulative effects rules (WAC 222-22-050).

The team may conclude that insufficient evidence is available from the Level 1 analysis to make a rating of vulnerability or hazard for a given area. In this case, Level 2 problem solving would be initiated to answer the unresolved questions. When a Level 1 or Level 2 assessment is complete, the products of resource assessment are forwarded to the DNR and to the watershed field managers team for prescription-setting and monitoring.

Procedure

The general approach for conducting synthesis is qualitative, where key data and observations from the individual assessments are brought together to determine the strength of the signal in determining the likelihood of a cause and effect linkage between hillslope and stream conditions. This process is intended to be a guide for this key component of the analysis. Importantly, synthesis is not a cookbook approach. Synthesis is an iterative process requiring repeated questioning and evaluation of watershed processes by the assessment team.

Synthesis includes the steps of resource assessment that require interdisciplinary dialogue. There is a logical sequence for performing tasks and producing products, but there is no set recipe for how a team works this process. A general sequence that the team may follow includes:

1. Individual modules present results to the rest of the team. This will get everyone up to speed on the general stories for each watershed process in the watershed.
2. Inter-team dialogues resolving any linkage products they have been assigned responsibility for, and to fill in any gaps.

Fish Vulnerability: Fish habitat/Stream channel teams.

Public Works Vulnerability: Public works/hydrology, mass wasting, riparian function.

Others as needed:

The need for other inter-team dialogue should become apparent when module products are presented.

3. Watershed Condition Hypothesis Development and Testing
The entire team works together to establish the watershed condition and cause and effect linkages. The resource condition reports are produced.
4. Resource Sensitivities
Once the overall functioning of the watershed is understood and cause and effect linkages established, the team needs to formally designate the sensitive areas from the module unit maps and use the rule matrix to determine the rule call. The causal mechanism reports are completed and prepared for forwarding to the field managers team.
5. Resource Assessment Report Completion
Complete products and package them in reviewable fashion.
6. Prepare for the Hand-off Meeting with the field managers.

Presentation of Module Products

Synthesis begins with reporting of the findings from each of the inventory modules to a full group meeting. Assessment products (i.e., maps, summary data, and text) are reviewed and explained among the team. Potential hazard areas are displayed for each watershed process. A clear description of what, if any, components of forest management activities affecting hazards are identified. The location and vulnerability of each important resource (e.g., fish habitat or capital improvements) is identified and described.

If appropriate, each presentation includes a discussion of why and where indeterminate calls were made and what additional information may be needed to resolve these calls. The confidence in work products is discussed.

Inter-Team Dialogue

There are a number of points specified in the modules where the analysts are expected to interact in order to mutually develop some of the interpretations and rule calls. Since most of these calls occur at or near the completion of the module products, these discussions may be conducted either prior to any group interaction during synthesis or during its early stages. They are discussed as a second step here because it may be useful for the analysts to learn what the other modules have discovered prior to assigning calls. Modules will also benefit from conferring among teams as resource assessment proceeds.

In particular, most of the resource vulnerability calls are made as a product of team dialogue. The public works module specifies that the analyst should consult with the hydrology, mass wasting, and riparian function module analysts to determine the vulnerability call. Fish habitat vulnerability is determined by dialogue between the fish habitat and stream channel teams. Because of the complex nature of fish habitat, the procedure for establishing vulnerability is described in detail.

The Fish/Channel Linkage - Making Vulnerability Calls

Prior to the synthesis steps that involve all of the assessment modules, the information and maps from the channel and fish habitat assessments must be brought together in order to define the habitat vulnerability calls. The following steps describe the general process by which the two resource assessments are used to create the vulnerabilities. It is important to bear in mind that habitat issues not covered in this manual may arise. The analysts must then rely on the data describing the situation and their knowledge of fluvial geomorphology and fish biology to create vulnerability calls.

The channel assessment produces a summary report which presents the results of the channel assessment. The report provides the context for interpreting the causes of historic channel change, identifies current channel condition, and presents a diagnosis of how current channel condition may react to changes in the various input factors. For each geomorphic unit (defined as a group of segments that respond similarly to the inputs), the relative potential for the channel to respond to each of the input factors will be rated. Accompanying this report will be a geomorphic unit response map which compliments the summary report by showing the spatial context of the potential channel responses.

The fish habitat assessment identifies the existing and historical distribution of the various fish species in the WAU. In addition, the assessment produces four maps showing areas of concern from the standpoint of fish habitat. Each of the maps will focus on one of the four life history stages (upstream migration, spawning and incubation, summer rearing and winter rearing). Each map will display reaches that have been identified as areas of concern (areas of degraded habitat, limiting habitats, refuge areas, etc.). Accompanying each map will be narrative descriptions of each area of concern and summaries of habitat conditions in the WAU.

Typically these two summaries will be organized at different spatial scales. For example, an area of resident cutthroat trout may encompass a large portion of a WAU that includes portions of a number of geomorphic units. It is recommended that the vulnerability calls be organized around the species

distribution, and that within each zone of the species distribution the analysts review the results of the two assessments for each geomorphic unit and identify processes influencing habitat formation.

Proceeding through geomorphic units one at a time, the channel analyst describes the potential response ratings and any relevant historical and current condition information. The fish habitat analyst describes the distributions of fish species and life-history stages and emphasizes areas of special concern in the unit. Together, the analysts work through combinations of life-history stage and channel sensitivity (Table 3) and identify the input factors that influence habitat formation in the unit. For each sensitivity rating, the analysts review the general and special habitat concerns for each life phase to determine if the fish habitat is or could potentially be vulnerable to an input factor in the geomorphic unit. The fish habitat analyst is responsible for reviewing the channel sensitivity calls and for determining whether the potential response ratings to each of the input variables are appropriate for protection of fish habitat. In some cases the habitat vulnerability may need to be raised or lowered from the channel response rating depending on fish habitat interpretations. Fish habitat is considered vulnerable if there is a causal linkage between the channel response and life history stage (e.g., Table 3) for input factor.

In many cases the level of habitat vulnerability to an input factor will be equivalent to the potential channel response rating. For example, if there is an area of special habitat concern due to spawning gravel degradation from sediment that corresponds to a geomorphic unit with a high sensitivity to fine sediment, then the habitat vulnerability to sediment is high. If a potential impact to a life history stage cannot be linked to a channel response for a specific input factor, then the habitat for the life stage is not vulnerable to the input factor.

In some cases, the fish habitat information and potential channel response rating will be inconsistent with respect to making vulnerability calls. This may occur in several ways:

1. Habitat conditions are poor due to the influence of an input factor for which the channel response has been rated low or moderate.
2. A unit rated as low or moderately sensitive to an input factor is an area of concentrated fish use (e.g., an area of high density spawning).
3. A unit rated as low or moderately responsive to an input factor is a habitat of limited availability (e.g., off-channel refugia are a limiting habitat in the WAU).

These and other inconsistencies may arise in a watershed analysis and must be addressed. The biologist and the channel module leader will need to work together to identify factors causing the inconsistency. Based on this evaluation, the problems may be discovered and the appropriate corrections made. In all cases, the fish biologist is responsible for determining whether the channel sensitivity rating appropriately describes the habitat vulnerability. If the cause of an inconsistency cannot be explained and resolved, the biologist will make the final vulnerability call. The biologist will rely on the results of the fish habitat diagnostic evaluation as a basis for the call. The relative condition of the habitat for a life phase and the parameter responsible for this condition is evident from the diagnostic evaluation. Habitat vulnerability would be determined from the relative condition indices.

Note: In some cases it may be possible to empirically determine the amount of an input that causes an adverse change in a resource condition. This additional information may be used to qualify the vulnerability call. For example, the use of a diagnostic sediment budget may allow the channel and fish habitat assessments to determine amount of coarse sediment that degrades summer rearing habitat.

Combinations of life-history stage and input factors must be addressed in creating vulnerability calls. Table 3 presents a list of the most commonly encountered situations that must be addressed in each watershed analysis. Other combinations of channel sensitivity and life-history stage may be addressed in addition to these.

Table 3. Combinations of Life-history Stage and Input Factors

Life-history Stage	Potential Channel Response
Upstream Migration	Coarse sediment (holding ponds)
Spawning and Incubation	fine sediment (incubation environment) peak flows (redd scour)
Summer Rearing	coarse sediment (pool filling) wood debris (pool formation and cover) temperature (appropriate temperature ranges)
Winter Rearing	woody debris (in channel refuge and cover) coarse sediment (pool filling) factors that create and maintain off-channel refugia

Watershed Condition Assessment

The next steps of synthesis are performed by the team as a whole. The team first develops the comprehensive watershed picture by examining the linkage between hillslope processes and resources for the indicator areas selected by the team. (The geomorphic units supplied by the stream channel assessment will serve as a basis for these units, although they may be modified.) The team will systematically work through the critical synthesis questions for each geomorphic input factor (change in coarse or fine sediment, change in peak flows, recruitment of large woody debris, or change in energy loading) for the indicator areas. It is strongly recommended that the field managers team observe the synthesis sessions of the assessment team. This will help them to understand how the resource sensitivity calls are made.

If the team is large, they may wish to use a facilitator for this part of the assessment. If so, it is strongly recommended that the facilitator be a knowledgeable resource specialist given the hypothesis development/testing nature of this exercise.

Questions are designed to capture the following:

1. Activities generating an input (e.g., coarse sediment).
2. Process triggered by activities (e.g., mass wasting associated with logging road failures).
3. Delivery to the stream.
4. Delivery of an effect - whether an input can be transported to a sensitive segment (and whether a material effect can be registered).
5. Public resources impact - whether resources can be or will be degraded.

Data and interpretations relevant to each of these points has been developed within the assessment modules as critical questions are addressed. Tables 4 to 8 list each of the primary synthesis questions and identify the associated questions and information that were asked and answered during inventory assessments. Sources of information to address the synthesis questions can therefore be found in the products of the assessment modules. The specified work products provide the evidence weighed by the team to answer the associated synthesis questions. The resource assessment team will find it useful to have the module summary reports and products in hand, and to have interim work products available for reference.

Table 4. Key Questions and Information Relating to Fine Sediment Processes

Primary Synthesis Questions	Primary Inventory Questions	Required Information	Module
<i>What is the channel sensitivity to fine sediment?</i>	Are there locations sensitive to changes in inputs of fine sediment?	Form E-5	Channel
	What do the current channel conditions indicate about existing levels of fine sediment inputs?	Sediment supply/transport capacity relationship	Channel
	Is there evidence that channel conditions relative to fine sediment are changed from historic conditions?	Supplemental Information	Channel
<i>What is the habitat sensitivity to fine sediment?</i>	What is the production potential rating for spawning and incubation?	Good, Fair, Poor calls from Worksheet F-4	Habitat
	What is the current habitat condition?	% fine sediment content of spawning gravels and other supplemental information. (Worksheet F-1)	Habitat
	Is there evidence that habitat conditions have changed from historic?	Supplemental information (Worksheet F-2)	Habitat
<i>What and where are the potential impacts producing fine sediment?</i>	Is there potential for shallow rapid failures?	Maps and Descriptions Map A-1	Mass Wasting
	Is there potential for debris torrents?	Map A-1	Mass Wasting
	Is there potential for deep-seated movement?	Map A-1	Mass Wasting
	Is there potential for road surface erosion?	Road surface erosion worksheet	Surface Erosion
	Is there potential for hillslope surface erosion?	Hillslope erosion worksheet	Surface Erosion
	Is fine sediment generated by management activities?	Maps A-1, B-1, B-2	Mass Wasting & Surface Erosion
<i>Is fine sediment delivered to segment of concern?</i>	Is fine sediment routed from the contributing impact to a susceptible location?	Worksheet I-1	Routing
	Will the delivery of fine sediment change the channel or habitat conditions?	Form E-5	Habitat
		Map F-3	or Channel

Table 5. Key Questions and Information Relating to Coarse Sediment Processes

Primary Synthesis Questions	Primary Inventory Questions	Required Information	Module
<i>What is the channel sensitivity to coarse sediment?</i>	Are there locations sensitive to changes in inputs of coarse sediment?	Form E-5	Channel
	What do the current channel conditions indicate about existing levels of coarse sediment inputs?	Sediment supply/transport capacity relationship	Channel
	Is there evidence that channel conditions relative to coarse sediment are changed from historic conditions?	Supplemental Information	Channel
<i>What is the habitat sensitivity to coarse sediment?</i>	What is the production potential rating for summer rearing?	Good, Fair, Poor calls from Worksheet F-4	Habitat
	What is the current habitat condition?	See percent pools and other supplemental information. (Worksheet F-1)	Habitat
	Is there evidence that habitat conditions have changed from historic?	Check supplemental information (Worksheet F-2)	Habitat
<i>What and where are the potential impacts producing coarse sediment?</i>	Are there potential shallow rapid failures?	Maps and Descriptions Map A-1	Mass Wasting
	Are there potential debris torrents?	Map A-1	Mass Wasting
	Are there potential deep-seated failures?	Map A-1	Mass Wasting
	How much coarse sediment is generated naturally for each impact? How much coarse sediment is generated by management activities for each impact?	Map A-1	Mass Wasting
<i>Is coarse sediment delivered to segment of concern?</i>	How much coarse sediment is generated naturally from all impacts in this basin?	Worksheet I-1	Routing
	Is coarse sediment routed from the contributing impact to a susceptible location?	Form E-5	Routing
	Will the delivery of coarse sediment change the channel or habitat conditions?	Map F-2	Channel & Habitat

Table 6. Key Questions and Information Relating to Peak Flow Processes

Primary Synthesis Questions	Primary Inventory Questions	Required Information	Module
<i>What is the channel sensitivity to changes in flood frequency and magnitude?</i>	<p>Are there locations sensitive to changes in peak flows?</p> <p>What do the current channel conditions indicate about existing flow conditions?</p> <p>Is there evidence that channel conditions are changed from historic conditions?</p>	<p>Form E-5</p> <p>Transport capacity (Form E-5)</p> <p>Supplemental Information (Form E-5)</p>	<p>Channel</p> <p>Channel</p> <p>Channel</p>
<i>What is the habitat sensitivity to changes in flood frequency and magnitude?</i>	<p>What is the production potential rating for spawning and incubation?</p> <p>What is the current habitat condition?</p> <p>Is there evidence that habitat conditions have changed from historic?</p>	<p>Good, Fair, Poor calls (from Worksheet F-4)</p> <p>Supplemental Information (from Worksheet F-1)</p> <p>Supplemental Information from (Worksheet F-2)</p>	<p>Fish Habitat</p> <p>Fish Habitat</p> <p>Fish Habitat</p>
<i>What and where are the potential impacts producing changes in flood frequency and magnitude?</i>	<p>Where are potential rain-on-snow impact areas?</p> <p>What % of each potential impact area is hydrologically immature?</p>	<p>Watershed hydrologic condition map</p>	<p>Hydrology</p> <p>Hydrology</p>
<i>Are increased flows delivered?</i>	<p>What is the magnitude of the 2-year flood under mature forest conditions?</p> <p>What is the magnitude of the 5-year flood under mature forest conditions?</p> <p>Is increased water delivered to indicator segments during storm events?</p>	<p>Hydrographs for 2-year, 5-year, and 10-year floods</p>	<p>Hydrology</p>

Table 7. Key Questions and Information Relating to LOD Recruitment Processes

Primary Synthesis Questions	Primary Inventory Questions	Required Information	Module
<i>What is the channel sensitivity to changes in the size or frequency of large organic debris?</i>	Are there locations sensitive to changes in LOD?	Map (Form E-6, Map E-2)	Channel
	What do the current channel conditions indicate about existing levels of LOD?	Counts of LOD, size or volume information by channel width (from Form E-5)	Channel
	Is there evidence that channel conditions relative to LOD are changed from historic conditions?	Bilby and Ward target LOD loading levels (from form E-5)	Channel
<i>What is the habitat sensitivity to changes in LOD size or frequency?</i>	What is the production potential rating for summer rearing?	Good, Fair, Poor calls (from Worksheet F-4)	Habitat
	What is the current habitat condition?	Percent pools and other supplemental information (Worksheet F-1)	Habitat
	Is there evidence that habitat conditions have changed from historic?	Supplemental Information (Worksheet F-2)	Habitat
<i>What and where are potential impacts impairing the recruitment of large organic debris to the channel?</i>	Does the riparian zone stand age tree density, and species composition indicate current and continued supply of LOD?	Maps and Descriptions (Map D-1)	Riparian Function

Table 8. Key Questions and Information Relating to Temperature Regulating Processes

Primary Synthesis Questions	Primary Inventory Questions	Required Information	Module
<p><i>What is the channel sensitivity to increased water temperature?</i></p> <p><i>Is this different from habitat module?</i></p>	<p>Are there locations sensitive to changes in heat energy?</p> <p>What do the current shade conditions indicate about existing stream temperatures?</p> <p>Is there evidence that channel conditions relative to heat energy have changed?</p>	<p>Map D-2</p> <p>Shade conditions relative to target conditions (Form D-2)</p> <p>Supplemental Information (Form D-2)</p>	Riparian Function
<p><i>What is the water quality sensitivity to changes in heat energy inputs?</i></p>	<p>What is the production potential rating for summer rearing?</p> <p>What is the current maximum stream temperature relative to water quality standards?</p> <p>Is there evidence that temperature conditions have changed from historic?</p>	<p>Good, Fair, Poor calls (from Worksheet F-4)</p> <p>Maximum temperature value from Ambient Monitoring</p> <p>Supplemental Information (Worksheet F-2)</p>	<p>Habitat</p> <p>Habitat</p> <p>Habitat</p>
<p><i>What and where are the potential riparian shade impacts?</i></p>	<p>Is existing shade less than target shade?</p>	<p>Comparative shade values (Map D-2)</p>	Riparian Function
<p><i>Is warmer water delivered to the segment of interest?</i></p>	<p>Is temperature delivered from upstream segments?</p>	<p>Temperature data and/or shade conditions 1,000 ft. (305 m) above the response segment</p>	Riparian Function

Identify Indicator Areas

Due to limitations of time and resources, the team will not be able to directly evaluate the potential cumulative effects on all stream segments, especially for widely distributed public resources such as fish habitat or water quality. They will need to select representative areas that are appropriately distributed in the watershed as indicators of local or watershed scale responses. The stream channel module has determined geomorphic units that include stream areas with similar condition and sensitivity to changes in geomorphic inputs. These units should provide the nucleus for synthesis of watershed scale cause and effects, although the full team may wish to modify them somewhat to accommodate other factors.

Develop Watershed Process Hypotheses

Information from the inventory work products is used to develop understanding of the existing or potential effects of management activities on watershed processes and resource characteristics. Linkages among management activities, watershed processes, stream segments, and vulnerable resources are established through a hypothesis development process. Empirical evidence, process theory, or both are used during this assessment to confirm or examine the acceptability of each hypothesis.

The team begins the assessment by assuming the perspective of field investigator at an indicator area. Maps, tabular data and summary reports are available from the habitat, channel and process modules. Routing considerations are of primary importance.

The team now attempts to integrate and associate the information to produce hypotheses for watershed processes. This process is similar to the way a medical team might diagnose a patient's condition, utilizing tests, and historical work-up that are coupled with the skills and knowledge of specialists and generalists.

For reliable results, the watershed analysis team should identify competing hypotheses for each segment. Through team dialogue and association of current and historical data, it should be possible to dismiss certain hypotheses while defining others as more likely. For each segment, the existing channel conditions are characterized by the channel and habitat modules. Supporting data is recorded on appropriate forms (e.g., pool/riffle ratio, levels of coarse sediment loading). Points in the photographic record are noted where stream channel conditions may have changed. Before evaluation of causal mechanisms, the team should reach common understanding on current and recent trends in channel and habitat conditions. This will help focus the evaluation and facilitate hypothesis development and testing. A dialogue between the habitat analyst and the channel analyst is essential.

As hypotheses begin to form, the team should be aware of the potential for either erroneous acceptance or rejection of the hypotheses. For example, limited pools and aggradation may not necessarily be derived from management activities. The cause may be a natural sediment source. The team should qualitatively analyze alternative explanations. Using the module information, they should identify the most likely hypothesis or explanation. If the team does not reach agreement on cause and effect, an indeterminate call may be appropriate (Level 1).

The linking or routing of impacts from hillslope processes to stream segments is a critical element of the hypothesis development process. The team members need to define how routing processes work within the various response segments. The evaluation of these linkages for sediment and peak flow impacts requires an assessment of the evidence and processes affecting routing. The application of routing to potential hazards is fundamental in reading the landscape; the result is a translation of data into useful information used directly in the rule matrix. Beyond the regulatory context, the information may have other valuable uses for voluntary or cooperative actions. A routing assessment for these input variables is described in Module I: Routing. At this time, this routing assessment is very qualitative. It is hoped that this may become more quantitative in the future with sediment and water budgeting.

Because impacts from riparian processes are not likely to be routed downstream and are directly adjacent to the stream segment of concern, these impacts do not require a routing analysis.

The plausibility or strength of the signal for the hypotheses should be evaluated by a qualitative certainty assessment. For example, for some impacts, such as delivery, channel conditions and habitat conditions, there will be clear correlation (Figure 5). In other cases the connections will be less clear; this is the result of natural variability, level of resolution of the assessment methodology, and other factors. Here, potential problems may still be identified and hypotheses may still be constructed, but at a lower level of certainty. Lower levels of certainty will dictate Level 2 analysis.

Figure 5. Simplified example circumstances which result in higher or lower certainties in hypothesis development. When the certainty is low, the watershed analysis team will usually go to Level 2 analysis.

		Observed Habitat Sensitivity	
		YES	NO
Observed Impacts	YES	HIGHER CERTAINTY Clear impacts and clearly discernable habitat effect.	LOWER CERTAINTY Clearly active impact with no discernable habitat effect.
	NO	LOWER CERTAINTY No discernable potential impact, but unexpected habitat effect present	HIGHER CERTAINTY No discernable potential impact and no discernable habitat effect

This hypothesis generating process yields an interpretation of resource conditions within the watershed. This is discussed in the Resource Condition Report, which focuses on describing the watershed from the stream system view. This is a narrative describing the public resource(s) condition and vulnerabilities, and the interpretation of watershed processes affecting it.

The suggested format for the Resource Condition Report for each analysis unit is provided in Form 3.

An Example From the Tolt River

A resource condition report for the Lynch Creek indicator area is provided at the end of this section illustrating a compilation of information for the area. This area was one of 14 identified in the WAU. The format on this report is flexible. This example represents one team's interpretation of how to present the appropriate information.

Form 3. Suggested Resource Condition Report format. Alternative formatting should address the key points indicated.

I. Location Information

- A map indicating the area
- Watershed Location Information
- Streams Observed
- Applicable to Other Streams

II. Resource Condition

(This section is a narrative describing key watershed interpretations)

- Public Resources Situation
- Overall Interpretation
- Confidence
- Discussion Points or Remaining Questions

III. Key Observations and Notes

This section captures some of the key observations contributing to the interpretations presented above). These observations are drawn from all of the modules.

- Coarse sediment
- Fine Sediment
- Peak Flows
- Large Woody Debris
- Temperature

IV. Discussion of Vulnerability Call

Resource Sensitivities

When existing or potential hillslope hazards can be linked to their existing potential effect on resource characteristics then a resource sensitivity is established. The evidence is compiled and interpreted in Synthesis; hypothesis testing supports the team's conclusion.

Linking Mapped Units to Public Resources

Generally, the hazards are mapped areas or "polygons" within the watershed where specific watershed processes are found likely to be significantly affected by the management practices. Each hazard area is differentiated by a unique "triggering mechanism." That is, potential changes in specific watershed processes are isolated to a reasonable degree. Examples could include the following: shallow debris flows within valley inner gorges; ancient deep-seated earthflows from a glacial terrace; surface erosion from road cut and hillslopes; increased available water from rain-on-snow; or lack of shade from past harvest of riparian stands. Differentiating hazard areas by trig-

gering mechanisms related to specific processes (not activities) facilitates the development of appropriate management prescriptions for the area.

Hillslope impacts that may affect vulnerable resources are identified by superimposing the resource vulnerability maps (Maps F-2 to F-6, H-I & H-2) on the hillslope impact maps (Maps A-2, B-1 & B-2, C-1, D-1 & D-2). Working with one impact map and the corresponding vulnerable resource map (e.g., for coarse sediment, use mass wasting impact Map A-2 and fish habitat Map F-2), identify the stream segments that are least likely to be affected by the impact.

Consider this step to be a coarse screen with the objective of removing mapped units and blocks of segments from further consideration. Areas and segments not excluded are examined further for potential cumulative effects.

Overlap of Hazard Areas

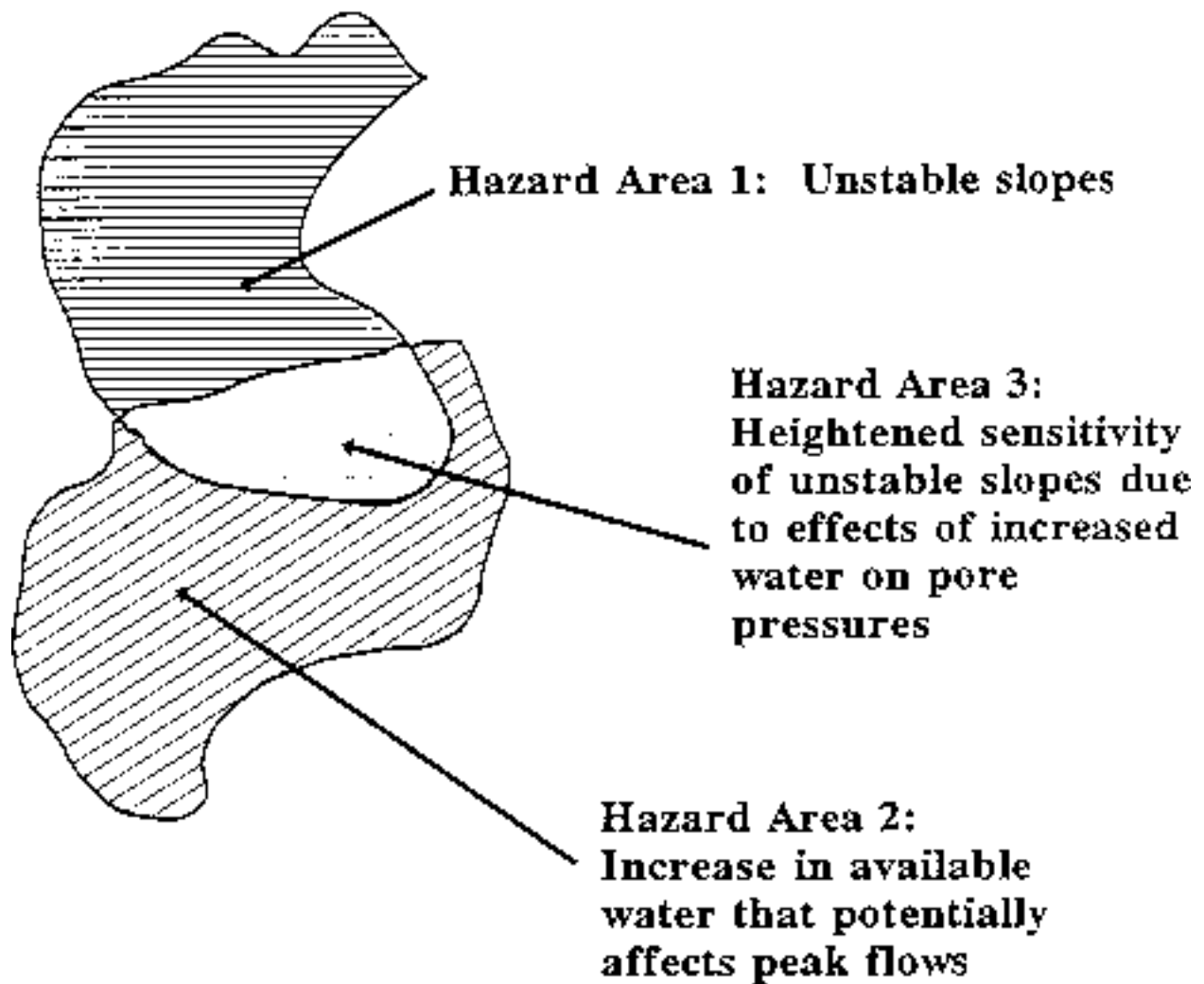


Figure 6. Overlap of Hazard Areas

Figure 7. Example of high habitat vulnerability to coarse sediment map (from Appendix Fig. F-3) superimposed on mass wasting impact potential map (from Appendix Fig. A-4)

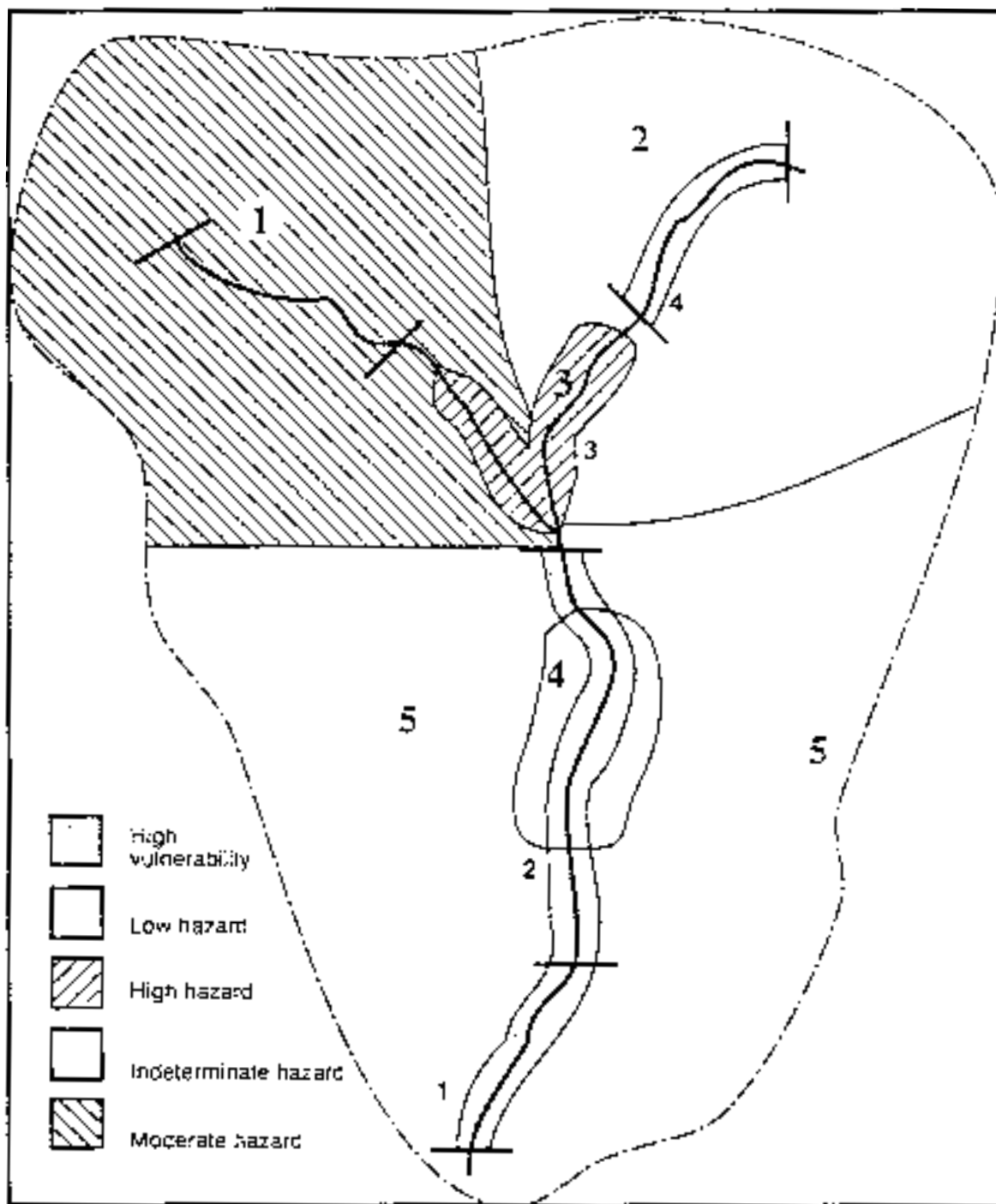
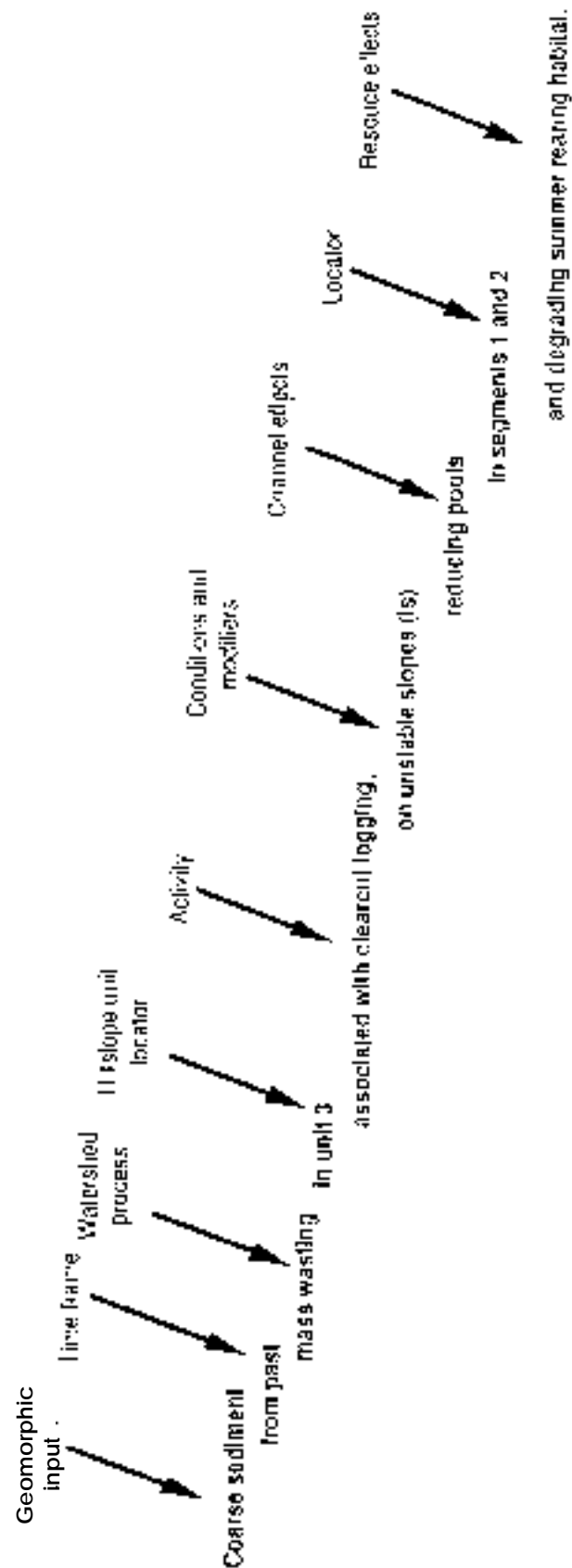


Figure 8. Situation Sentence Syntax



For example, the resource, fish habitat, can be divided into rearing habitat and reproduction habitat. Good spawning habitat demands high-quality spawning gravels. A risk to the resource is present when spawning gravels are degraded (or placed at risk) because of fine sediment loading associated with forest practices. A rearing sensitivity or risk arises when forest practices result in (or heighten the potential for) pool filling and reduction in summer rearing habitat.

The team should also consider the overlap of hazard areas to determine whether changes in more than one watershed process in that geographic area may heighten the potential hazard. Figure 6 illustrates this point. For example, if a change in available water in the rain-on-snow zone (hydrology unit 1) heightens the probability of shallow debris flow on unstable slopes (mass wasting unit 2) then a new area (3) enveloping the overlap in triggering mechanisms should be identified as a separate resource sensitivity. If the two hazards do not directly interact, then no additional differentiation is needed; they remain and are treated as separate hazards.

Resource Sensitive Areas

If a mapped area can produce delivered changes in coarse or fine sediment, water, wood or energy resulting in significant adverse impacts on stream and habitat conditions, then the mapped area is termed a “resource sensitive area.” Some hazard areas identified in the inventory modules may not become resource sensitive areas if significant impacts cannot be delivered. It is important to note that the resource sensitive area is designated relative to the hazard area rather than to the stream segments with which it is associated.

As depicted in Figure 7, a resource effect may arise when a change in hill-slope process (e.g., a road failure) generated material (e.g., coarse sediment) that can affect channels or otherwise impair resource function. The evaluation of effect must include an assessment of delivery to a stream and the responsiveness or vulnerability of resources to the input. Various stream segments will respond differently to each of the inputs. The method must recognize this by defining conditions under which responses are registered.

To provide accountability, the team compiles key summarized information for each resource sensitivity; each such sensitivity must have demonstrated that the linkages between sources, routing, channels, and habitat or water quality have been evaluated. These linkages and their rationale are accounted for in the Resource Condition report.

Although this background information is useful for accounting for how the resource sensitive area was identified, the information needed by the field managers team to address the sensitivity must be focused on the processes

and mechanisms by which forest practices can influence the area. This information is provided in a Causal Mechanism Report, which briefly states the problem and elaborates more fully on its potential causes.

The problem statement for each resource sensitive area is termed a “situation sentence.” The team confirms each of the key elements of the sentence with reasonable certainty based on the evidence (Figure 8 Situation sentence syntax). Each sentence is constructed based on the empirical or process theory evidence used to justify the linkages; the linkages are clearly documented in the routing, watershed process, and resource modules. The completion of all of the elements of the sentence represents a confirmed hypothesis of hazard linked to a vulnerable resource. Therefore, the existence of the situation sentence signals that the team has compiled enough evidence to identify a resource sensitivity and the content of the sentence expresses the nature of the problem. If one of the key sentence elements is not present, or of insufficient magnitude to be of concern, then that situation component is not confirmed; here, the linkage of hazard to vulnerable resources is not established, the sentence is not completed, and a problem is not found to exist for the purposes of the watershed analysis rules. In this case, the identified hazard area is not considered a resource sensitivity.

The key information developed by the scientists that will help the field managers team to develop appropriate prescriptions is the triggering mechanism. This is as good a description as possible of what the analyst believes is the factor that contributes to the potential to change a watershed process sufficiently to create the sensitivity. The analyst is encouraged to be as specific and detailed as possible. Simply saying that logging causes problems is incomplete. A clear articulation of what aspects of logging (e.g., soil displacement associated with highlead logging), is important in the development of appropriate prescriptions.

Rule Calls

For decision-making within the rule, the resource assessment team also makes a rule call that determines the standard of performance for prescriptions based on the risk to resources. In the synthesis stage, the team has the relevant information with which to establish with reasonable certainty the relative likelihood of an adverse change in watershed processes associated with particular practices and the relative vulnerability of the public resources to changes in those processes. This qualitative determination sets the performance standard for prescriptions according to Figure 9.

The Washington Forest Practices Rules (WAC 222-22-050) specify that data from the assessments determines the appropriate management response, the rule call. The rule call, the management response, is defined by the rule matrix in Figure 9. To correctly use the rule matrix, potential hazards must

be capable of being routed to a vulnerable resource. This is the question of deliverability. Deliverability is defined in the rules as the likelihood that a material amount of wood, sediment, or energy will be delivered to fish, water, or capital improvements of the state. This definition of deliverability has three conditions that must all be satisfied before an impact is delivered: (1) an impact is likely to occur, (2) the magnitude or size of the impact is sufficient to have a significant adverse effect on the resource characteristic, and (3) the impact is likely to be delivered to a stream segment with a vulnerable resource.

Each hillslope impact identified by the situation sentences must be evaluated for deliverability. Information needed to assess deliverability is derived from the data supporting the situation sentences. The likelihood of the event and its magnitude are elements of the module impact ratings. The likelihood of impacts reaching vulnerable resources is derived from the routing assessment. Because riparian impacts are not likely to be routed downstream and are directly adjacent to the stream, these impacts are assumed to be delivered and no further analysis is required. For sediment and peak flow impacts, the linkages between impacts and vulnerable resources must be established to determine deliverability.

Deliverability is determined for each input variable by examining linkages between the hillslope and the indicator areas. Beginning with the indicator areas closest to the potential impact, the team determines deliverability. This is repeated for each successive indicator area, for each impact area, and for each input variable. Impacts that are delivered to indicator areas are recorded by unit, map number, and rating on Worksheet 1.

Cumulative Effects Rule Matrix

		Likelihood of Adverse Change and Deliverability		
		L	M	H
RESOURCE VULNERABILITY	L	Standard	Standard	Prevent
	M	Standard	Minimize	Prevent
	H	Standard	Prevent	Prevent

Figure 9. Matrix Used to Produce Management Response Call for a Given Basin Problem Statement (from WAC 222-22-050)

Delivered potential impact and vulnerability determinations are combined to produce prescribed management responses (Figure 9). The X axis refers to potential impact from changes in watershed processes delivered to resources, and the Y axis refers to resource vulnerability.

The rule matrix produces three possible management responses:

1. Standard rules
2. Minimize
3. Prevent or avoid

The causal mechanism report is a compilation of the synthesis results. To condense this information into a readily usable format, the situation sentence products and supporting data are summarized on the causal mechanism report Summary (number it Form xx) using the format suggested in Figure 4. This form is prepared for each resource sensitivity that was developed in the synthesis phase. A causal mechanism report should be completed for each resource sensitive area, although parts of it may be completed by the resource assessment teams prior to synthesis.

This format is designed to assist the team to develop an understandable report without extensive written documentation; the team is encouraged to include observations or discussions in an appropriate level of detail, that increase clarity or justification of the conclusions.

Causal Mechanism Report Summary

WAU: _____

Resource Sensitivity Number: _____

Situation Sentence: _____

Triggering Mechanism(s) (Be as precise as possible): _____

Rule Call for Management Response: _____

Additional Comments: _____

Form 4. Suggested Format of the Causal Mechanism Reports.

An Example from the Tolt River - Causal Mechanism Report

Form 4. Causal Mechanism Report Summary

WAU: *TOLT*

Resource Sensitivity Number:
Mass Wasting Hazard Unit #1

Situation Sentence:

Coarse and fine sediment from past landslides in Unit #1 associated with roads and timber harvest within inner gorges has reduced pools and degraded cutthroat (and possibly dolly varden and bulltrout) spawning, and summer and winter rearing habitat in the North Fork braided reaches (Segments 13, 15, and 17). Sediment from this unit is also routed downstream and can affect depositional areas such as segments 1, 2, 3 and 5.

Triggering Mechanism(s) (Be as precise as possible):

Failures are mainly associated with roads, both sidecast failures and fill failures. Stream crossing failures are the result of the active transport of wood debris and bedload down these channels, causing plugged culverts. Harvest of the very steep slopes adjacent to streams has accelerated mass wasting. This is due to root strength deterioration and changes in groundwater hydrology. The larger melt rates and volumes due to clearcut harvest may lead to an increase in saturated thickness causing failure. Given the elevation and rock type, root strength is the more important of the two.

Rule Call for Management Response:
Prevent or Avoid

Additional Comments:

Dolly varden and rainbow may be present. Unit #1 is a naturally unstable area. Delivery associated with Segments 13, 15 and 17.

Resource Assessment Report

The majority of the Watershed Analysis Report for the WAU will consist of the resource assessment products. It is recognized that producing a full written report for the watershed would be a very time consuming effort for the team and is not possible within the time constraints of the watershed analysis regulation. The report consists of a compilation of key products produced during the course of the assessment. Once the prescriptions are completed by the field managers team, they can be added to report to complete the watershed analysis products. It may be most useful for review purposes to append each prescription to the appropriate causal mechanism report.

Watershed Characteristics

The watershed characteristics information is recorded on Form 5. Most of the information for this form will be derived from the start-up phase.

Resource Condition Reports

These reports provide the watershed interpretations for each of the geomorphic units of the watershed. They convey in narrative form findings of the team including public resource condition, contributing hazards, and routing assumptions. They also record the resource vulnerability calls with supporting evidence.

Causal Mechanism Reports

The situation sentence is recorded along with the triggering mechanism and rule call. In addition, the specific supporting information (e.g., input variable and the resource affected) and source of the information (e.g., map or source data) are recorded. The actual maps, data, and worksheets are included as appendices.

The contents and format of this report are listed in Figure 11. Because landowners, agencies, and other interested parties will be using and reviewing watershed information for more than one WAU, a common report format is necessary to facilitate easy reference.

Figure 11. Suggested format for the Resource Assessment Report**Resource Assessment Report**

- A. Watershed Characteristics (Label Form 5)
Team Personnel (Form 1)
- B. Resource Condition Report - one for each indicator area (Form 3)
- C. Causal Mechanism Report - one for each resource sensitive area (Form 4)
Situation Sentence
Rule Call
Trigger Mechanism
Confidence Discussion
Supporting Data
- D. Module Summary Reports (see each module)
- E. Maps

Appendices

- A. Assessment Module Products
- B. Synthesis Products

Hand-off

Although the field managers team is encouraged to attend in the Synthesis stage of Resource Assessment, and therefore may be familiar with the scientific findings, it is important for the resource assessment team to formally hand off their product to the field managers team. This should be accomplished in a meeting setting with the focus on explaining the causal mechanism reports. This will ensure that the field managers fully understand their contents. It may also be useful for resource analysts to consult with the field managers during prescription writing.

An Example from the Tolt River Resource Condition Report

Indicator Area: Lynch Creek

Watershed Location Information:

Major tributary to the South Fork Tolt River below the dam.

Streams Observed:

Lynch Creek and Crazy Creek (Segments 119, 122, 124) were visited by the Channel and Fish Teams.

Applicable to other streams:

Entire Lynch Creek. (Segments 112-117); Crazy Creek (118-124); and Segment 125, a tributary to Lynch Creek.

Macro Story

Public Resources Situation:

Lynch Creek is presently inhabited by resident cutthroat trout. Anadromous species are prevented from moving into Lynch Creek by perched culverts at the pipeline road. An old stringer bridge downstream of the pipeline road was apparently a blockage in the past but is not a barrier today. A shotgun culvert in Segment 116 may become a barrier if not maintained. Beaver dams at several locations in the system may also form barriers.

The channel gradients and confinements characteristic of the system create good spawning and rearing potential. Current conditions are rated as at or near potential in most locations. The spawning habitat is sensitive to fine sediment contamination. Free-flowing reaches are sensitive to wood loss because LOD is an important pool-forming agent in these areas. The abundance of beaver ponds in some segments of this system are probably warmer than free-flowing reaches in the system. This may heighten sensitivity to temperature increases in these areas.

Crazy Creek is notably different than Lynch Creek. Large slides in headwater segments (122-124) dominate stream characteristics now and will into the future. Fish habitat in Segments 119-124 is off potential due to (1) high levels of fines in gravels and pools, (2) continuously turbid water from exposed clays in slide areas, (3) extremely low pool to riffle ratio (4-10% pools) due to filling by sediments, (4) continuous channel shifts in Segment 120, and (5) a potential fish migration barrier at the upstream end of Segment 118.

An Example from the Tolt River Resource Condition Report

Overall Interpretation:

A number of landslide hazards throughout the sub-basin chronically contribute both coarse and fine sediment to Crazy Creek. Elsewhere in the Lynch Creek basin is relatively benign except in incised portions of the channels where bank erosion is (Segment 112) or may become (Segment 116) problematic. Active mass-wasting processes include road and non-road related shallow debris flows and ancient deep-seated landslides. The contact between hard rock walls and glacial till deposits are the location of significant mass wasting concerns is not a problem. The roads have a few problem erosion locations but generally are in good condition. Channels in active landslide locations of Crazy Creek are active and destabilized. Beaver ponds occur in the lower alluvial channels providing storage for sediment. Target shade conditions are generally reached except for some locations.

Fish habitat conditions for spawning and rearing are good in the basin, although access for anadromous species is currently blocked by a culvert barrier at the lower end of the basin. The main pipeline culverts are perched, preventing fish movement.

Confidence:

Confidence in hazard identification and channel condition is good based on the methodology and field observations. It is assumed that removing the migration block would allow steelhead use of available habitat.

Discussion points or Remaining Questions:

- Did sockeye salmon use Lynch Lake at one time? Are they present in the lake now?
- What is the seasonality of the hydraulic connection of Lynch Creek to the South Fork Tolt?

An Example from the Tolt River Resource Condition Report

Coarse Sediment

Channel Condition:

- Crazy Creek Segments 121 and 122 of Crazy Creek flow across the earth flow area. The channel there is characterized by loose boulder stairsteps and appears to be very active and destabilized.
- Upper reaches are zones of transport bringing coarse and fine sediments down to the alluvial reaches.
- Headwaters shifting, unstable, milky color during high flow events. Non-cohesive banks.
- Where streams leave the slide area and flow only the glacial tills, the channel is initially lost and then re-emerges and flows into beaver pond channels.
- Lower Lynch Creek cuts down through sheer vertical walls of clean sand.

Public Resource Effects and Sensitivity:

There are some good spawning gravels available in the system. No evidence of coarse sediment problems relative to fish habitat.

Habitat in Segments 119-124 of Crazy Creek are seriously off potential due to:

- High incidence of fines in gravels and pools.
- Continuously turbid water due to input from exposed clays in slide areas.
- Extremely low pool to riffle ratio (4 to 10% pools) in most segments. Pool filling with both coarse and fine material.
- Recent and continued shifts in Segment 120.
- Fish migration barrier at Old Stringer Bridge/Beaver Dam at upstream end of Segment 118.

Barriers:

- Stringer bridge downstream of Pipeline Road did in the past and may in the future be a barrier, but it currently is not a passage barrier.
- Culverts at Pipeline Road are a barrier.
- Beaver dam at Lynch Lake outlet is probably a barrier.
- Beaver dam on Lynch bank tributary and Lynch proper may form barrier.
- Shotgun culvert in Segment 116 is partially plugged causing water to flow down roadway during min or high flow events.
- Beaver dam at Stringer Bridge in 118 and 119 may be a barrier.

An Example from the Tolt River Resource Condition Report

Coarse Sediment *Continued*

Vulnerability Rating:

MODERATE: good potential and good existing habitat conditions in Lynch Creek proper. High vulnerability in Crazy Creek. It currently has good habitat potential in its alluvial reach and currently has poor habitat condition.

Contributing Hazards:

General:

- Edge of continental glaciation.
- There is a problem area associated with a precipitous rock wall. Ancient landslide mixed between rock and old till is related to ice-margin sediments. These slip off the hard rock walls.
- Recent road and non-road related slides related to an ancient landslide. There has been a lot of recent slide activity, especially in upper Crazy Creek.
- The rest of Lynch Creek on the glacial plain is not a problem.
- Roding is tricky.
- Landslides chronically generate both coarse and fine sediments.

Specific Areas:

- Mass-wasting Units 4-2 and 4-3 (rock slopes) (HIGH).
- Mass-wasting Units 20-22 and 20-23 (ancient landslides) (HIGH).
- Mass-wasting Unit 3 (fault trace) (HIGH).

Identified Fish passage barriers.

Routing Considerations:

Routing from upstream to downstream low-gradient reaches occurs.

Confidence:

Good confidence on hazard identification and channel response based on method and field observations.

An Example from the Tolt River

Resource Condition Report

Fine Sediment

Channel Condition:

- Fine sediments from landslides were observed trapped in beaver dam areas of Crazy Creek.
- Very high V* of silts and sands behind beaver dams (40-80% fill with yellow cake sediments). The source appears to relate to mass-wasting, based on observations that sediment color matches the geology.

Public Resource Effects and Sensitivity:

- Segment 112 has some spawning gravel but only fair potential according to default call.
- No sediment sampling was conducted, but there appeared to be fine sediments stored in this segment. Elsewhere in Lynch Creek proper, spawning habitat appears to be in good condition.

Vulnerability Rating:

HIGH: based on current deposition of fines and good potential for rearing and spawning habitat.

Contributing Hazards:

- Bank erosion in Segments 112 and 116 are major sources for Lynch Creek proper.
- Landslides a major source of fines in Crazy Creek.
- No evidence of surface erosion from hill slopes related to soil or terrain.
- There were some trouble spots on roads (see map and list).
- Windthrow of riparian vegetation has uprooted trees, creating some erosion exposure in a location in Lynch Creek.
- Beaver dam failures could pose problem -- see catastrophic events section.

Routing Considerations:

Sediments routed from upper watershed to lower watershed and stored in beaver ponds.

Confidence:

Good, based on method and observations by field team.

An Example from the Tolt River Resource Condition Report

Peak Flow

Channel Condition:

- Channels are very unstable in the upper reaches of Crazy Creek and could be affected by flows.
- Wide low-gradient sections in the middle reaches are probably not affected by flows.

Public Resource Effects and Sensitivity:

If fall spawning salmon occur in the Crazy Creek now or in the future they will be vulnerable to peak flows. No evidence of past effects.

Vulnerability Rating:

HIGH: based on vulnerability of channels to peak flows

Contributing Hazards:

General:

- Most of the basin is in the rain-dominated zone.
- Some of the vegetation is in sparse category but most is in small dense and large dense.
- Susceptibility to enhanced flows is inherently low and the vegetation is now in a favorable situation.
- Estimated Q2 increase is 6%.

Specific Areas:

None identified.

Routing Considerations:

None

Confidence:

Upper reaches of Crazy Creek could be affected by peak flows, but the channel is so active that it's difficult to determine the influence of peak flows separate from the influence of sediment loading. Peak flows are probably not dominant, however.

An Example from the Tolt River Resource Condition Report

Large Woody Debris

Channel Condition:

- Lynch Creek channels have moderate wood volumes in areas not influenced by beaver dams.
- Crazy Creek channels are generally low in wood. Where present, wood functions in trapping sediment and forming stairsteps in the steeper sections.
- Boulders are also functioning in forming pools.
- Moderate levels of LOD functioning to create pools in free-flowing segments of Lynch Creek proper.
- Low amounts in Segment 112.
- Sensitive to loss of in-channel LOD or interrupted recruitment.
- Low-gradient channel nature means most of the wood remains within the system.
- Lack of LOD in Crazy Creek above Segment 118 -- sensitive to further loss where beaver dams don't form pools.

Public Resource Effects and Sensitivity:

- There is good rearing habitat in the beaver dam reaches and elsewhere in Lynch Creek proper.
- There are not many pools and not much LOD in the upper reaches of Crazy Creek but there is a lot of wood in the beaver pond segments.

Vulnerability Rating:

HIGH: based on function in providing pools and trapping sediments.

Contributing Hazards:

General:

- Harvest within the last 10 years has left many stands in young conditions. About 70% of the system is rated as situation category RF1 (see maps dd-2 and dd-5).
- Most of the riparian area below Lynch Lake, except along the beaver ponds, are low in recruitment potential.

Routing Considerations:

None

Confidence:

Good based on method and field observations.

An Example from the Tolt River Resource Condition Report

Catastrophic Events

Channel Condition:

- Evidence that the channels in the upper reaches have experienced debris flows entering them in the past.
- Lower reaches are too low in gradient to pass debris flows through them.

Public Resource Effects and Sensitivity:

Immediate effects disastrous, indirectly affect spawning and rearing conditions in downstream areas of Crazy Creek and in Lynch Creek (Segment 112) where materials may be routed.

Vulnerability Rating:

HIGH, if occur.

Contributing Hazards:

- The old Stringer Bridge is now a beaver pond. It could pose erosion hazard and fish migration problems.
- Dam break floods from this or other beaver ponds in Crazy Creek could devastate downstream reaches in Lynch Creek.

Routing Considerations:

Confidence:

Good

An Example from the Tolt River Resource Condition Report

Temperature

Channel Condition:

Shade in beaver pond areas is achieved through alder, vine maple and willows covering most wetted areas, even when overstory shade is below target.

Public Resource Effects and Sensitivity:

May exceed water quality standards in reaches with low shade. Beaver ponds may be particularly susceptible to increased temperatures.

Vulnerability Rating:

HIGH

Contributing Hazards:

- There is adequate shade along much of the stream.
- Target shade is not being met in some locations (see map d-4).
- Depending on temperatures in Lynch Lake and its associated wetlands, the influence of this lake on downstream temperatures may be positive or negative.

Routing Considerations:

Inflow from Lynch Lake and associated wetlands may increase water temperature in segments below.

Confidence:

MODERATE. Based on TFW temperature method. Offsite influences could affect temperature not considered in method. Temperature monitoring would improve confidence

Form 5. Watershed Characteristics Format

Watershed Administrative Unit:

Drainage System: _____

Location: _____

Basin Area (acres): _____

Climate: _____ Mean Annual Precipitation: _____

Elevation Range: _____

Geology: _____

Stream Density (mi/mi²): _____ Road Density (mi/mi²): _____

Vegetation (dominant): _____

Vegetation (sub-dominant): _____

Land Use: _____

Major Land Owners: _____

Water Supplies: _____

Major Capital Improvements: _____

Fisheries Resources: _____
